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ABSTRACT

The first purpose of this study is to help the reader become aware of the evolution of Statistical Process Control (SPC) as it is being implemented and used in industry today. This is approached through the presentation of a brief historical account of SPC, from its inception through the technological miracle that has occurred in Japan. The concept of control charts and related statistical methods is presented in sufficient detail to provide the reader with a basic understanding of the techniques used in SPC and to provide a frame of reference for discussing and drawing conclusions regarding training in SPC. The second purpose is to equip the reader with an understanding of the impact of SPC on quality and productivity. In this regard, the study explores the capacity of vocational-technical education in Ohio to respond to industry and provide the needed services in SPC. SPC initiatives at the state level are discussed, and a number of SPC initiatives around the nation are described to serve as exemplary models for Ohio to draw upon in solving its own needs for improving qualtiy and productivity. (YLB)

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STATISTICAL PROCESS CONTROL

IMPACT AND OPPORTUNITIES FOR OHIO

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Foreword

A major challenge facing American industry is being reflected in the vocational-technical programs of Ohio's secondary schools and two-year postsecondary institutions. The challenge is three-pronged:

- To improve the quality of manufactured goods;
- To increase productivity; and
- To achieve a competitive edge among industrial nations.

Global economics, with its impact on industry, is creating an environment that will force less competitive plants to close, erode the industrial employment base, and accelerate the movement of jobs to offshore locations.

According to Dr. W. E. Deming, a leading exponent of the application of statistical methods to manufacturing processes, the main source of hope for the revitalization of American industry is fundamental change in the way industry conducts its operations. Of foremost importance is the need to provide for fuller participation of labor in the decision-making process, and for labor to accept responsibility and ownership in its own work area.

Statistical Process Control (SPC), along with a management philosophy that reflects Deming's fourteen points for management, offers an opportunity for industry to increase productivity and assure high quality in its product.

In this report, Dr. Harold H. Brown, Vice President Emeritus, Columbus Technical Institute, has presented a brief, but well developed and comprehensive, treatment of the major topics one must understand in order to insure quality and productivity in manufacturing processes.

Dr. Joseph L. Davis, Executive Director

Glenn E. Selby, Chairperson

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Purpose of the Study

This study has two primary purposes. The first is to help the reader become aware of the evolution of Statistical Process Control (SPC) as it is being implemented and utilized in industry today. This is approached through the presentation of a brief historical account of SPC, from its inception through the technological miracle that has occurred in Japan.

The concept of control charts and related statistical methods is presented in sufficient detail to provide the reader with a basic understanding of the techniques used in SPC and to provide a frame of reference for discussing, and drawing conclusions regarding, training in SPC.

The second purpose is to equip the reader with an understanding of the impact of Statistical Process Control on quality and productivity. Dr. W. E. Deming, the world's foremost authority on SPC, states that 85 percent of the problems in the system can only be corrected by management while only 15 percent of the problems are correctable by taking action at the worker's station. Thus, the key to improving quality is to identify and separate these two categories of problems through the use of Statistical Process Control and then take appropriate corrective action.

How will the American worker learn the language of SPC? What is the proper role of vocational and technical education in this regard? These questions are addressed in this report, conclusions are stated, and recommendations are presented.

Design of the Study

1. The literature was reviewed with the aim of identifying and discussing techniques of Statistical Process Control (SPC), pattern analysis, and the relationship between SPC, quality, and productivity.

2. Data were collected to measure the capacity of public two-year colleges and secondary vocational education programs to help and support industry in the implementation of SPC.

3. Selected authorities in SPC, in both public education and private industry, were interviewed on the role of secondary vocational and postsecondary technical education in training employees and helping industry implement SPC.

4. The role of the American Society of Quality Control relative to two-year colleges was explored and reported.

5. State and national initiatives were reviewed for their impact on SPC training and implementation in Ohio.

6. Interviews were conducted in selected categories of industry to determine present and future need for SPC training and implementation.

7. Data and information collected through interviews and surveys were analyzed, and conclusions and recommendations drawn in order to meet one of the stated purposes of the study.

8. A mini-course in SPC was developed in order to help the casual reader achieve a level of awareness sufficient in depth to understand the impact of SPC on competitive position.

A Historical Perspective of Statistical Process Control

Background Information

The use of statistical thinking and methods in the control of manufacturing processes is not new. Statistical methods were first applied to the problems of quality control by Dr. Walter A. Shewhart, of the Bell Telephone Laboratories. In a memorandum prepared on May 16, 1924, Dr. Shewhart made the first sketch of a modern "control chart." He published a book on statistical quality control in 1931, which bore the title Economic Control of Quality of Manufacturing Products.

It was not until the outbreak of World War II that American industry began to utilize SPC significantly. This was brought on by the armed services' need for large quantities of high quality goods and services.

By the end of World War II, the United States had become the most powerful and prosperous nation in the world. With much of Europe's and Asia's industrial base destroyed, people hungered for consumer goods. The U.S.A. began producing a seemingly endless supply of refrigerators, automobiles, radios (and later televisions), and other civilian products to meet the demand of world markets while other countries were rebuilding their industries. America had a near-monopoly on most world markets, and with the capacity to sell everything we produced, there was little need to constantly improve quality; hence, statistical methods were soon discarded. It was less expensive to inspect and sort than to spend money improving the manufacturing process. American industry was run on the quarterly financial report and its main concern was to "Run it"..."Ship it"..."Make money."

Introduction of SPC in Japan

Japan, in contrast to the United States, was in ashes at the end of World War II. Japanese industry was totally destroyed. Japan was unable to feed itself, and it was occupied by a foreign power — the United States.

In 1950, Dr. W. E. Deming, an expert in statistical methods, arrived in Japan to teach and help install statistical methods in Japanese industry. He predicted that if his lessons were learned and applied, Japanese products would, within five years, invade the markets of the world and that the standard of living in Japan would, in time, rise to equality with that of the world's most prosperous countries.

The dramatic rise in the quality of Japanese products and the equally sensational improvement in Japanese efficiency in production are well known. What hasn't been so well known is how these improvements were achieved. The answer does not lie solely in labor costs, tax laws, or cultural differences. As Robert Reid (1985) has observed, "Management, quality, the worker, and statistics have allowed Japan to knock a little sense into the world."

Need for Statistical Process Control

Impact of Foreign Imports

There was a time when products that carried the "Made in the U.S.A." label were eagerly sought after because this label was perceived to stand for excellence of quality. While the quality of American products has continued to improve, the rate of improvement has been relatively slow. In contrast, Japanese products, before and immediately after World War II, were regarded as cheap, and of low quality. This did not last for long. In the early 1950's, Japanese quality began to improve at a remarkable rate, and by 1975, was on a par with product quality in the western world, as portrayed in Figure 1.

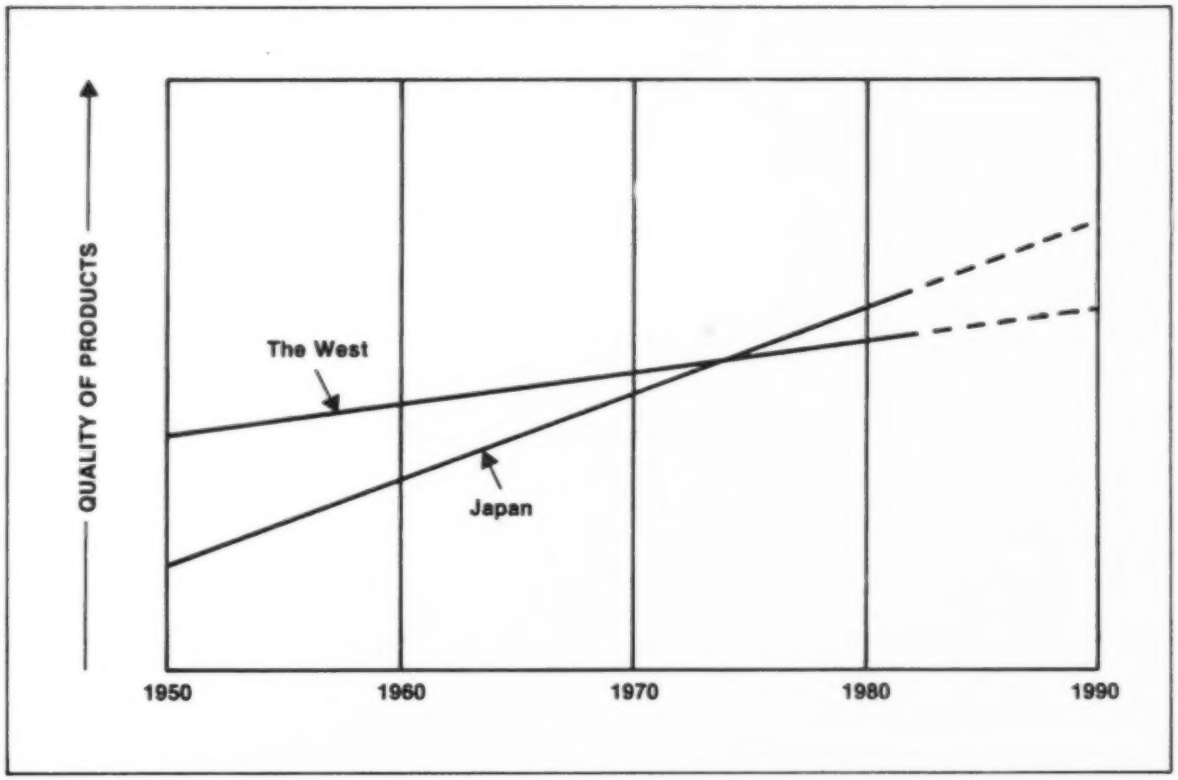
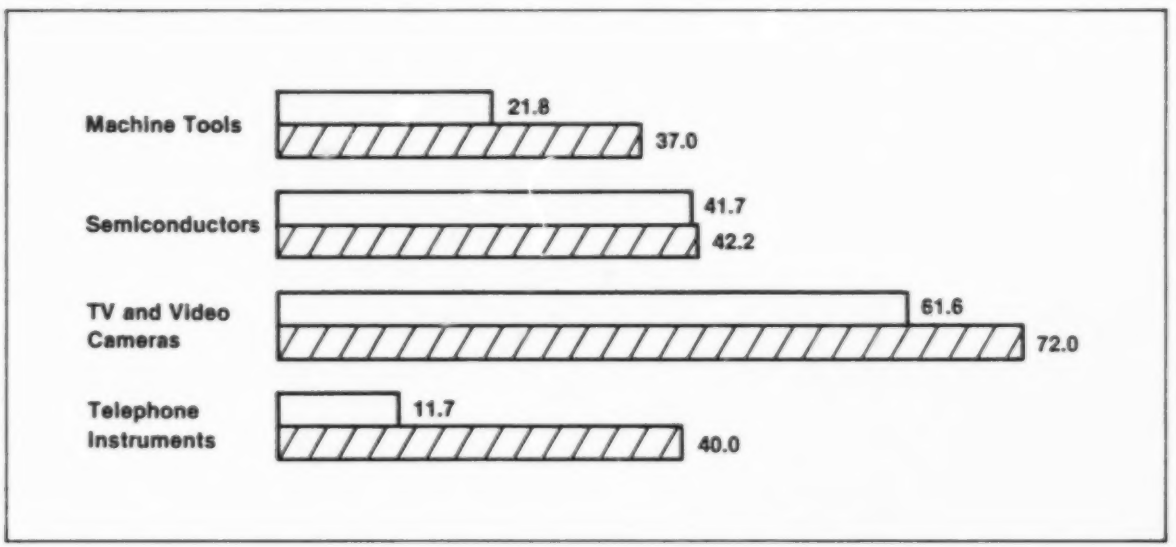


Figure 1. Relationship Between Quality of Products in Japan and the West (as developed by Dr. J. M. Juran)

During the past ten years, the quality of Japanese products has continued to improve at a faster rate than that of products made in the west. As a result, the Japanese now enjoy an advantageous position. In short, America has been bested at the game it invented.

While Japanese imports are highly visible throughout the nation and the object of the greatest attention, it is necessary to look at all off-shore products to understand the full impact of foreign-made goods.

Figure 2 shows that foreign-made goods currently are accounting for increasingly larger shares of American markets in many industries, from basic commodities and apparel to high technology equipment.



(The white bar represents the import share of each product in 1981; and the cross-hatched bar, the share in 1985.)

Figure 2. Import Share of Selected Products
(Source: Staff of the U.S. International Trade Commission)

An analysis of Figure 2 strongly suggests that world economic leadership is at stake.

Consider, for example, the entire electronics industry, one in which the United States has been dominant for years. In 1985, for the first time, the U.S. electronics industry ran a deficit with Japan. In every major electronics market, imports are rising, exports are falling. At this rate, most products will eventually be manufactured off-shore, and the U.S. will become little more than a huge distribution center.

Quality and Productivity

What is quality? The word is used so loosely in everyday life that its real meaning is often lost. Everyone speaks of quality — everyone is for it. In industry, most companies claim their goal is to offer the customer a quality product. But what exactly is meant by a quality product? Do you know it when you see it? It might very well depend on your point of view. Quality often means different things to different people, and even different groups within the same company may disagree on what makes a quality product.

Quality can be viewed from several dimensions. One dimension is that of Conformance to Requirements, where there exists a wide variety of product requirements, such as specification limits, customer needs, fitness for use, competitive levels, and performance criteria. Viewed from this dimension, perfect quality means total conformance to all stated product requirements. "Zero defects" represents the thinking on which this view is based.

A second dimension is Cost of Quality, which implies the cost of poor quality generated by nonconformance to requirements (an extension of the first dimensional view). Examples of costs of quality are inspection cost, testing, calibration, disposition of rejected material (scrap or rework), and warranty cost. Reducing the cost of poor quality to "zero" is considered by many the ultimate achievement.

A third dimensional view holds that Design Optimization for lower cost is the primary requirement. The expected result of design optimization is improved quality through the achievement of product and process uniformity. "Quality engineering" represents the thinking and knowledge behind this dimension of quality.

J. M. Juran, writing in the Quality Control Handbook (1974), states that of all quality concepts, none is so far-reaching as "fitness for use," as judged by the user. This implies that an essential requirement is that products and services respond to the overall needs of the user, and the extent to which the product or service successfully serves the purposes of the user during usage is its fitness for use.

High quality and high productivity must be the ultimate goals of industry, if American industry is to have any hope of achieving and maintaining a competitive position in world markets. The relationship between productivity and a competitive edge is clear, but what is not so clear is the relationship between quality and productivity.

In addressing this issue in his book Quality, Productivity, and Competitive Position (1982), W. E. Deming states, "Folklore has it in America that quality and production are incompatible; that you cannot have both. A plant manager will usually tell you that if he pushes quality, he falls behind in production. If he pushes production, his quality suffers. This will be his experience when he knows not what quality is nor how to achieve it. In meeting with a group of production workers, in response to my [Deming's] question, 'Why is it that productivity increases as quality improves?' Their response was less rework. There is no better answer."

Deming's Cure

For years, Dr. W. E. Deming has been prescribing the cure for what ails American industry. And the proof of his cure is in the successful transformation of Japan from a country in ruins to a world-class industrial giant.

According to Deming, there are two basic sources of unacceptable variation from quality standards in any process. The first of these sources is "common causes." These are causes of variation that are common to the entire system of production. They are also referred to as "chance causes" because they behave in a random manner or like a constant system of chance causes. Common causes account for 85 percent of non-acceptable outputs and are correctable only by a management decision to redesign the system.

The second source is "special causes." These causes of variation can be traced to a single cause of worker or machine error; they behave in a non-random

fashion. They are detectable through the use of control charts and can usually be corrected by local action; i.e., by the person directly connected with that portion of the process. "Special causes" account for 15 percent of unacceptable output. (Common and special causes are defined and/or explained on page 12 under "Concept of Variation.")

The key, then, to improving quality and productivity, is to control the process that makes the product and remove the special causes of variation in the process by local action; in other words, to use Statistical Process Control (SPC). Common causes can only be removed by management action on the system. Application of these principles of management, using SPC to improve quality, reduces manufacturing costs significantly. Unlike traditional quality control systems that use detection after product production, SPC prevents the production of defective products since it is an on-going, on-line process.

Fundamental to the successful implementation of SPC is a corporate culture that recognizes and treats human resources as its most valuable resource. This implies the involvement of workers in a joint corporate partnership as participants in the decision-making process. This is evidenced by shifting appropriate responsibility from the top downward through the ranks to allow the worker the opportunity to influence decisions and solve problems that relate directly to his/her own job and work process.

Management knows how the process should work, but the worker knows how the process does work. Workers on the line often see things that go wrong or ways to do the job better. Unfortunately, management often fails to seek the help workers could provide. Management personnel need to understand that they can't be in action areas at all times, and therefore need assistance from people on the line who are aware of day-to-day and hour-to-hour problems. It is the blending of these two levels of knowledge that can create an environment that will support the highest level of productivity. A wall plastered with control charts without worker involvement is insufficient to insure successful implementation of SPC.

SPC Fundamentals: A Mini Course

Detection vs. Prevention Systems

American companies have typically used what is termed "detection" as a means of control, a method that relies on product inspection after the product has been made. This after-the-fact inspection separates acceptable products from those that are unacceptable. Unacceptable products are then scrapped or reworked. The disadvantage of the detection system is that unacceptable products can be produced before there is an opportunity to inspect for acceptability. Since it costs the same amount to produce an unacceptable product as it does an acceptable one, and an additional cost is incurred if an unacceptable product is reworked, it is obvious that a detection system is an extremely wasteful quality-control method. Also, inspection systems that require inspection of every item produced simply do not work well because some defective items will be missed due to error.

Imagine a monitoring system that could be added to the process with the ability to provide signals that would issue a warning whenever the process was not capable of producing acceptable products. Such a system is available. It is termed "prevention," and Statistical Process Control is the monitoring device.

SPC - What is it?

Statistical Process Control (SPC) is a method of using statistical techniques to collect and analyze data from a process. The analysis is then used as the basis for making decisions about the process.

The goal of any manufacturing process is to produce uniform, acceptable items consistently. This can be achieved only by a process that is "in statistical control." "In statistical control" is a term further explained under "Control Charts"; see page 13.

SPC uses control chart techniques that provide statistical signals which, when properly interpreted, will indicate whether the process is in or out of statistical control.

Concept of Variation

Variation is universal: a fundamental law of nature is that physical objects cannot be precisely repeated time after time, or that no two things are exactly alike.

Manufacturing processes are subject to variation and, therefore, cannot make products exactly alike time after time. It is highly desirable, however, to keep variations among like products as small as possible.

It is generally accepted that all variation in manufacturing processes is caused by one or more of the following factors: machines, materials, people, methods, and environment. At times, words such as measurement and management have been added to the list.

When variation from these sources fluctuates in a normal, expected or random manner, the variation is considered to be from common (chance) causes. Common causes of variation are very small in magnitude and are inevitable in all processes. They occur by chance and are difficult to identify and correct.

When variation from these same sources fluctuates in a non-random, unexpected manner, the variation is considered to be from special (assignable) causes. Special causes of variation are large in magnitude and can be identified and corrected.

Basic Control Chart Theory

The most important tool in SPC is the control chart. It provides statistical signals that, when properly interpreted, tell when the process is either "in control" or "out of control."

To understand what is meant by a process being in or out of control, we must first remind ourselves of two basic points, previously stated: (1) the goal of a manufacturing process is to produce uniform, acceptable products, and (2) the extent to which the process is able to achieve this goal is determined by the amount of variation in the process that shows up in the end product (the extent of non-uniform products).

When the process is "out of control," it means that special (assignable) cause is present and is the source of large variations occurring in the end product. Under this condition, the process is producing items that are unacceptable for use, and the items must be scrapped or reworked to make them acceptable. This increases the cost per item and reduces productivity.

When the process is "in control," it means that no special cause is present and only common (chance) cause is operating in the process. Under this condition, the process is producing uniform, acceptable items for use. A process "in control" is also referred to as stable and predictable — predictable in the sense that the process can be expected to produce acceptable items with a 99.73 percent certainty.

The key, then, to bringing a process "in control" is to determine if special cause is present and, if so, to take action to remove the cause. The usefulness of the control chart lies in its ability to signal when special cause is present in the process and for action to be taken, or to signal that only common cause is present and to leave the process alone.

$\bar{X}$-R Control Chart

Figure 3 is a typical $\bar{X}$-R control chart ($\bar{X}$ means "average" and R means "range"). The major components of this chart are described without reference to the various formulas used for calculating chart parameters. Each numbered statement below corresponds to the circled number on the section of the chart being described.

1. Think of the day's production as a "population of products." At regular intervals, samples are drawn from the day's production (population), as the items are produced. Measurements of the samples are recorded in the Control Chart.
2. The average ($\bar{X}$) and range (R) for each sample are calculated and plotted.
3. The average ($\bar{\bar{X}}$) of the sample averages ($\bar{X}$) (called process average) and the range averages ($\bar{R}$) are calculated and drawn as horizontal lines on the chart.
4. Control limits (Upper Control Limit - UCL; Lower Control Limit - LCL) for the average and range are calculated and drawn as horizontal lines on the chart. Control limits are located $\pm$ 3 standard deviations from the process average. ("Standard deviation" is a statistical measure of variability that is readily calculated, using data like those shown in Figure 3.)

A prime use of this chart is to determine if any of the sample averages and range values lie outside the control limits. Note that Samples 11 and 18 fall outside the upper control limit. The interpretation of those phenomena is that the process is out of control. When this is determined, adjustments or repairs are made to bring the process back in control.

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The control chart, then, is a visualization of the variation occurring within the process and is presented in such a way that it tells if any action should be taken on the process.

Operation SHAFT PINS Spec. 21-50 MM Gage _____

Unit of Meas. .010 MM Zero Equals _____ Operator JONES

Date																			
Time		8:00	15	30	45	9:00	15	30	45	10:00	15	30	45	11:00	15	30	45	12:00	15	30
① Sample Data	1	33	38	39	30	35	28	48	28	28	32	50	33	21	23	30	28	21	58	43
	2	35	43	40	35	38	37	40	30	30	46	56	35	35	34	30	37	29	58	3
	3	33	38	40	35	33	37	45	24	26	37	58	43	35	23	26	35	22	50	
	4	33	43	35	36	44	43	37	31	35	36	58	33	36	23	36	36	21	56	
	5	43	32	32	32	40	35	45	24	26	32	58	33	32	24	28	32	22	58	
Sum		177	194	186	168	190	180	210	137	145	180	280	177	168	127	150	168	115	280	
② Average		35.4	38.8	37.2	33.6	38.0	36.0	42.0	27.4	29.0	36.0	56.0	35.4	33.6	25.4	30.0	33.6	23.0	56.0	
Range		10	11	8	6	9	15	8	7	9	11	8	10	6	9	10	9	8	8	
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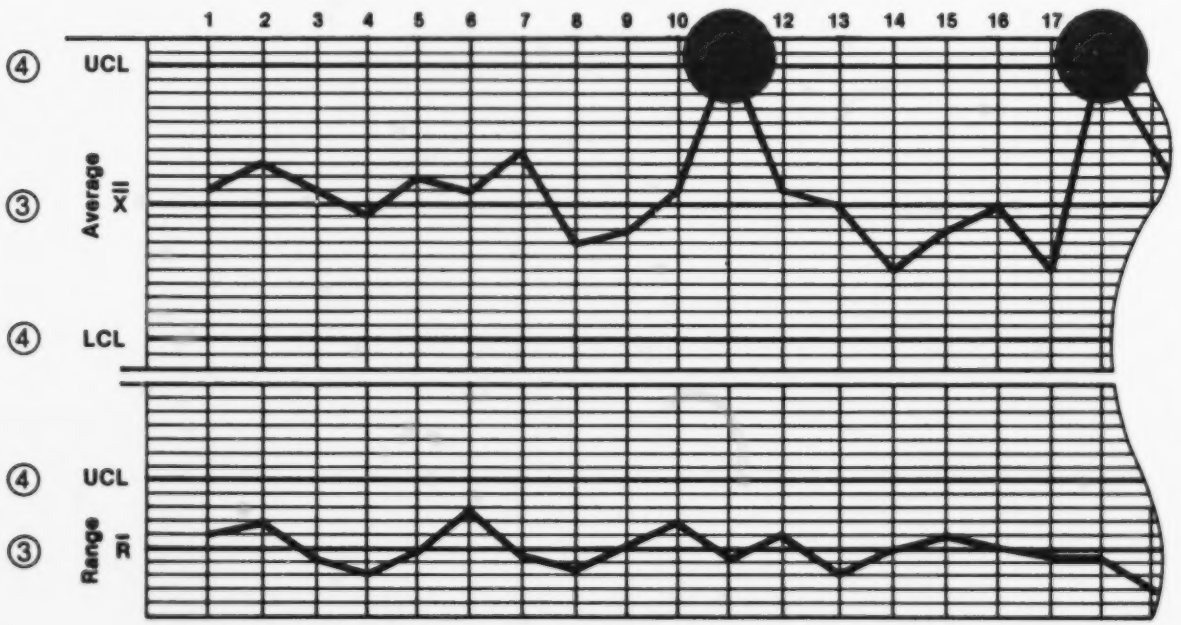

Figure 3. $\bar{X}$-R Control Chart

Ohio's Capacity to Support SPC

Industry has a need for implementing and training employees in SPC. At times such as this, industry has historically turned to the vocational-technical education community for assistance. It is no different in this case. The question is whether or not vocational-technical education has the capacity to respond to industry and provide the needed services in SPC.

A survey of Ohio's two-year college system and adult vocational education programs in joint vocational schools was conducted in order to assess their capacity to support business and industry in the quest for improved quality, productivity, and competitive position.

In the postsecondary two-year college system, the survey revealed that 17 of the 24 institutions had faculty members trained in SPC and were offering courses and workshops to business and industry both in-plant and on-campus. The extent to which the individual schools were involved varied dramatically, which was an indication of their own level of development in this field.

The college system had 50 faculty members who were qualified trainers in SPC and provided 301 SPC offerings of all kinds, including noncredit short courses, credit courses, workshops, and seminars. A total of 8,700 people had gained some level of understanding in SPC by taking advantage of these offerings.

The survey also indicated that at least half of the colleges planned significant increases in the number and frequency of course offerings during calendar year 1986.

In vocational education, survey information was derived from a sample consisting only of schools known to be involved in SPC. However, the data obtained in this manner provided a solid base for drawing sound inferences.

The vocational schools also were involved in offering adult vocational SPC courses of various lengths to industry both in-plant and in-school. The vocational schools had approximately 25 trained SPC instructors and another 20 instructors in training. Nearly 4,000 people had been trained in 140 course offerings. The effort to date has been highly successful, with several of the schools reporting that requests from industry for SPC training exceeded their capacity to respond. A few schools that had previously restricted their activity to secondary students in vocational programs, were planning to offer adult vocational SPC courses.

Industrialists and educators who were interviewed on the topic of Ohio's capacity to support SPC voiced concern over the inability of vocational schools and technical colleges to respond to the growing need of industry to train its people in "design of experiments." ("Design of experiments" is the technique of using analysis of variance to determine the main effect of several process variables on the outcome of the final product.) Interviewees indicated that two-year colleges should develop the capacity to deliver training programs in this statistical method. The high level of advanced statistics needed for this technique would preclude it from being taught at the vocational level.

It is clear that Ohio has within its secondary vocational education programs and two-year colleges a critical mass that can be further developed and organized into a powerful statewide SPC effort capable of supporting industry to a much greater extent than is now occurring. Such an effort could contribute much to the further revitalization of Ohio's sluggish economy.

SPC Initiatives at the State Level

Three significant developments at the state level are having a profound effect on SPC training in Ohio: (1) discovery by the State Division of Vocational and Career Education of a desperate need for a cadre of qualified SPC trainers, (2) preparation of a course of study in SPC for secondary vocational programs, and (3) Ohio Department of Development support of SPC training.

The need for SPC trainers became apparent when the Division began to receive inquiries, at an accelerating rate, concerning the availability of SPC training. The impetus for this training sprang from the adoption and implementation of SPC throughout the operations of Ford and General Motors, each of whom then mandated that their suppliers do likewise. This operational order had an impact on numerous automotive-related industries throughout the state, and their need for SPC training was immediate and urgent.

In response, the State Division of Vocational Education appointed a statewide committee on SPC. The committee's membership included adult vocational education directors, Ohio Industrial Training Program consortium directors, a University of Akron Two-year College specialist, and several Ohio Department of Education personnel.

The committee recommended that a series of seminars be conducted under contract with the American Supplier Institute (ASI). ASI, a former training unit of the Ford Motor Company, is considered to be a world leader in training for Statistical Process Control.

The University of Akron contracted with ASI to offer three intensive one-week seminars at The National Center for Research in Vocational Education, The Ohio State University. This training effort produced a total of 52 educators qualified as trainers in SPC.

The second development noted above involved the selection of four teams of writers, trained in SPC, to develop and write a course of study under a $30,000 grant. The course was designed around five modules: Introduction to Quality Control, Statistical Literacy and Techniques, Understanding SPC, Control Charts, and the Integration of these fundamental ideas through four projects designed to simulate real world problems.

The development effort includes a teacher-information guide, objectives, visual aids, and a variety of student handouts. It is planned that the course will be used as an elective math course or integrated into an appropriate vocational program for related study.

At this writing, the course materials were undergoing field testing at five joint vocational school districts, with the University of Akron conducting the evaluation of the project.

The Ohio Department of Development, through the Ohio Industrial Training Program, provides reimbursement to companies to help them with costs of training their workers in new developments. Training in SPC is among those training programs eligible for reimbursement. The training program also supports SPC training for industrial training with the stipulation that they then provide SPC training within their own company. Public institutions, too, may be reimbursed for having an individual trained in SPC provided that SPC training is then made available to area industries.

SPC Initiatives Around the Nation

A number of initiatives and other activities are occurring across the nation that may well have importance for Ohio if for nothing more than to serve as exemplary models for the state to draw upon in solving its own needs for improving quality and productivity.

A Significant Initiative

The most significant and ambitious initiative, "The Transformation of American Industry," had its early beginnings at Jackson Community College in Michigan. Working closely with Ford Motor Company, JCC developed a model program based soundly on Deming's management philosophy, statistical tools, techniques, and upon the on-going efforts of local industry to change. The impetus for JCC's development of the program came from the community's heavy dependence on the auto industry. Severely impacted by the industry's economic downturn, JCC took a leadership role in local economic development activities and hosted a "Quality Mandate for the 80's Conference" in September, 1982. This conference gave birth to the training model that would be used as a National Training Project.

The National Community College Training Project, "The Transformation of American Industry," was launched in April, 1984. The project's purpose is to build a capacity within the nation's community colleges to help business and industry in their drive to improve quality, productivity, and competitive position.

The project has the backing of both industry and education. Industry sponsors include the Ford Motor Company, General Motors, TRW, and AMCAST Industrial Corporation. Other sponsors are the American Association of Community and Junior Colleges (AACJC), Iowa Productivity Consortium, Michigan Department of Education, and American Society for Quality Control (ASQC).

Other Activities Around the Country

In Iowa, the Iowa Productivity Consortium has joined with ASQC to deliver "The Transformation of American Industry" program to business and industry through the

state's fifteen area community colleges. The consortium delivery plan provides for an ASQC consultant to help each of the fifteen college facilitators with local program design and evaluation. There are also four state chief trainers, selected from ASQC members, who oversee training of instructors for the community colleges. Funding has come from a vocational education grant of $40,000 approved by the State Department of Public Instruction and from $50,000 in JTPA funds. The program has the support of Governor Terry Branstad, who stated, "It is vitally important that our vocational schools offer Iowa workers the training that industry needs to stay competitive in the marketplace."

In Michigan, Governor Blanchard's Office for Job Training provided $500,000 for the Michigan Community College Association to build a statewide capacity specifically to help suppliers in the auto industry. The supplier network is targeted as a critical industry in the state's economic development efforts; an essential part of that effort is to help suppliers meet the new quality/cost requirements of the auto industry.

Michigan's 20 community colleges now have trainers who conduct "The Transformation of American Industry" sessions, both on campus and at suppliers' own facilities.

In Wisconsin, State Representative Susan Magnussen has introduced a bill to provide $155,000 for courses to teach SPC to industry.

A recent national initiative is the Quality/Productivity Training Network announced by the American Association of Community and Junior Colleges and the American Society for Quality Control. This joint venture links together AACJC's 945-member institutions and ASQC's 200 sections in a national effort to create a nationwide communication network for community colleges and ASQC sections to share quality/productivity training resources and case studies.

Dr. Deming (in an interview with Carol Hannon of Jackson Community College, Michigan) says, "The community colleges must do it. They are alive to their customers. They are learning how they can help industry in their communities. They must work together because there are a lot of problems that are common to all communities. I believe it [the community college] holds the key to teaching American industry what must take place."

Industry Speaks

High cost, low productivity, and loss of competitive position have brought industry to the realization that it can no longer survive by doing business as usual.

The automotive industry was the first to accept this premise, primarily because of the loss of market shares to the Japanese automotive industry.

The Ford Motor Company was the first of the giant automakers to announce a change from a quality approach of defect detection to one of defect prevention. Under this concept, suppliers are fully responsible for the quality of their products and must ensure that their products comply with all requirements prescribed by Ford. Further, each supplier is responsible for ensuring that all products and services it purchases from subsuppliers for use in Ford products perform to the same set of requirements.

Ford requires that suppliers use Statistical Process Control as an integral part of the supplier's process to provide the information necessary for never-ending improvements in quality and productivity. Control charts are required for those process parameters and product characteristics that affect function, durability, subsequent manufacturing operations, or appearance of the product. Suppliers are expected to utilize data from the control chart to identify opportunities for continually reducing variation in process output.

The reward to the suppliers for meeting Ford's high requirements is preferred quality status that will carry a preferred position in new-part-development programs and in source selection.

Obviously, these requirements by Ford (and other automotive companies) have had a tremendous impact on automotive-related companies in Ohio. These companies comprise the largest group with the greatest need for SPC training. Since many of these companies are located in the northern part of the state, it should come as no surprise that the northern vocational schools and two-year colleges have the largest SPC training programs.

Most of these companies, in looking ahead, see the need to encourage secondary vocational educators to teach SPC fundamentals to their students. And a few companies in the machine trades are, in fact, making knowledge of SPC a requirement for employment. This will stimulate vocational-technical educators to consider making revisions in the curriculum.

The SPC events that are occurring in the automotive industry are having a ripple effect throughout all of industry. More and more companies are becoming aware of the significant improvements in quality and productivity in the automotive industry and are beginning to place similar SPC requirements on themselves and their suppliers. The requests for SPC training in response to these new requirements have outstripped the ability of the schools and colleges to deliver the training. The adoption of SPC will continue to gain momentum until application of statistical methods is a normal part of manufacturing processes. It is no longer a question of whether SPC should be implemented in any given company, but a question of when should it be implemented, and the sooner the better.

Summary

1. High cost, low productivity, and loss of competitive position are forcing industry to make drastic changes in the way companies are managed.

2. An increasing number of companies are beginning to follow the lead of the automotive industry by implementing Statistical Process Control (SPC).

3. Suppliers of products and services to the major automotive companies are being required to have SPC in-place as an integral part of their quality control program.

4. A small number of companies are including SPC training among those skills required for employment. This practice will become more prevalent in the future.

5. The public two-year colleges and adult vocational education programs are taking the lead in providing SPC training. Between the two, approximately 12,000 Ohioans have been trained to date.

6. There is a growing acceptance among vocational educators and industrialists that students enrolled in vocational programs should be trained in basic statistical methods.

7. The level of SPC training being offered by vocational-technical education is limited to on-line methods, such as control charts.

8. No statewide formal organization exists in Ohio with responsibility for encouraging and supporting SPC activities, including the training of SPC instructors.

9. A national initiative, "The Quality/Productivity Training Network," links the two-year college system with the American Society of Quality Control to form a network for promoting SPC from coast to coast.

10. A number of states have concluded that it is in their best interest economically to encourage and promote SPC training by making substantial financial support available to schools and colleges.

11. Ohio has the nucleus for a statewide SPC training effort unparalleled in the country. This is an opportunity Ohio can ill afford to ignore. With appropriate financial support and aggressive marketing of SPC training, Ohio could reap significant benefits in retraining personnel for industry and attracting new industry into the state.

Recommendations

1. Secondary vocational education programs should be revised to include a basic course in statistical methods for manufacturing processes. As a minimum, vocational graduates should be literate in Statistical Process Control (SPC).

2. Associate degree programs or majors in Manufacturing Technology should provide a solid foundation in statistical methods through offering at least one course in Statistical Process Control and preferably a two-course sequence.

3. Two-year college faculty members responsible for SPC training should develop the capacity to offer a course in off-line quality control: Design of Experiments.

4. The two-year college system should join the AACJC/ASQC Quality/Productivity Training Network.

5. The state of Ohio should encourage, and invest financial support in, the formulation of an SPC organization responsible for developing a statewide capacity for training instructors and delivering SPC training to industry throughout Ohio.

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